

*Top Quark Physics*  
*and*  
*Searches for New Phenomena*  
*at the*  
*Tevatron*

*Presented at*

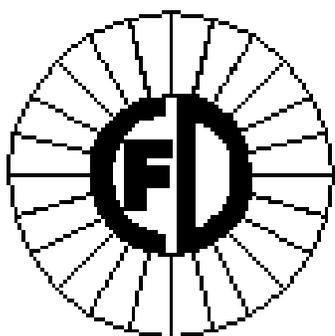
**XXVII International Symposium on Multiparticle Dynamics**  
Laboratori Nazionali di Frascati - INFN Frascati - Italy

**Raymond E. Hall**  
*for The DØ and CDF Collaborations*

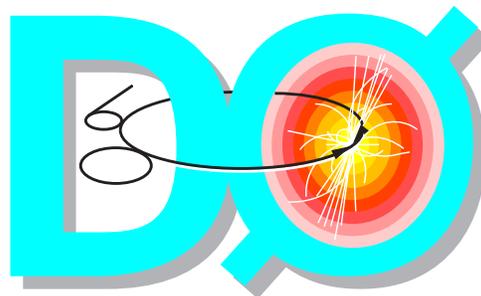
University of California, Irvine  
September 8, 1997

# Outline

*reporting on results from:*



*and*



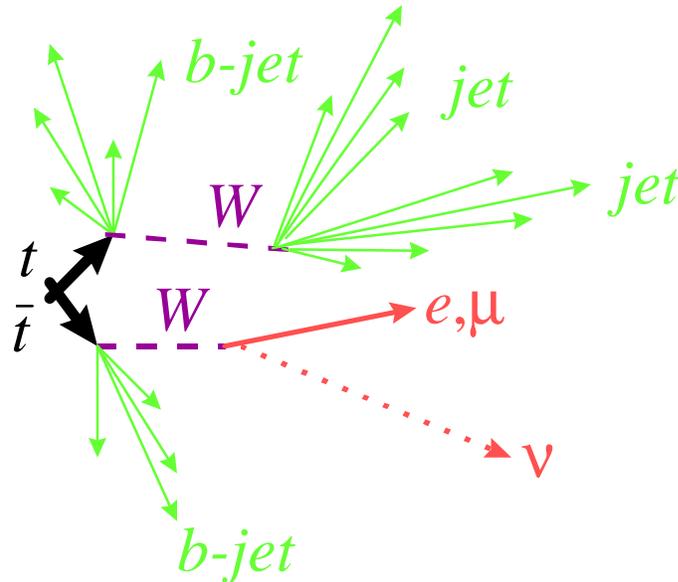
- Top Physics
  - ◆ Top Quark Mass
  - ◆ Top Quark Production Cross Section
  - ◆ Other Top Measurements
- Searches for New Phenomena
  - ◆ Mass Limits on  $LQ_1$
  - ◆ Missing Et + Jets in SUGRA
  - ◆ Summaries of Other Search Analyses
- Conclusions

# *Top quark production and decay*

At Tevatron:  $qq \rightarrow t\bar{t}$  (90%)  
 $gg \rightarrow t\bar{t}$  (10%)  
 $t \rightarrow Wb$   $W \rightarrow \ell\nu$  or  $q\bar{q}$

Channels classified on basis of  $W$  decay:

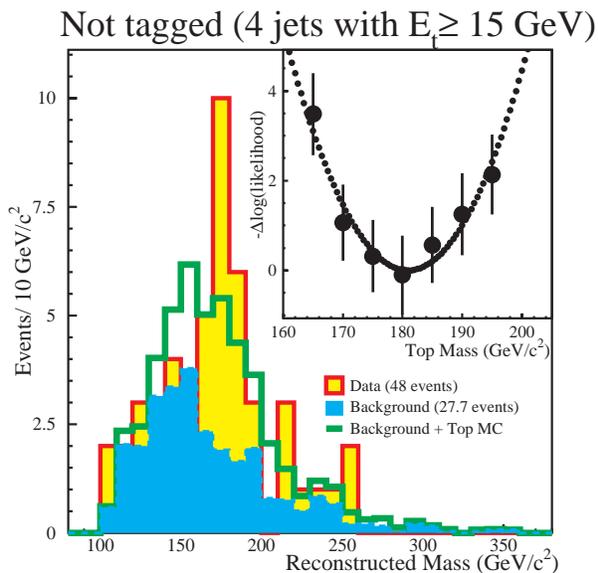
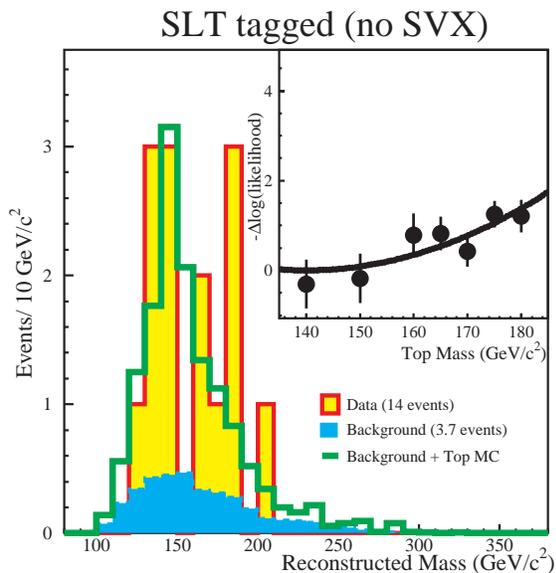
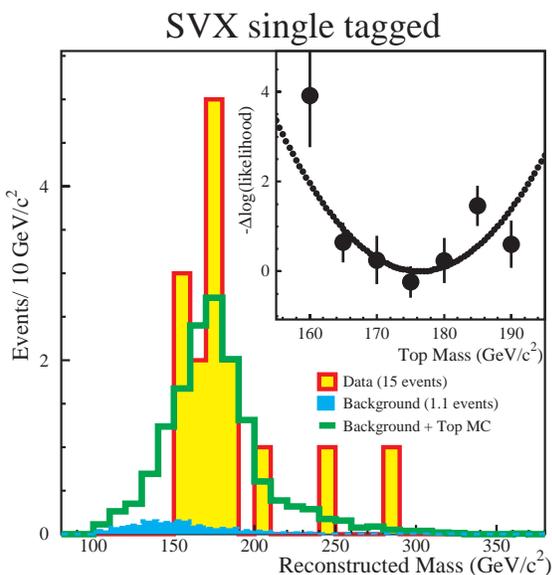
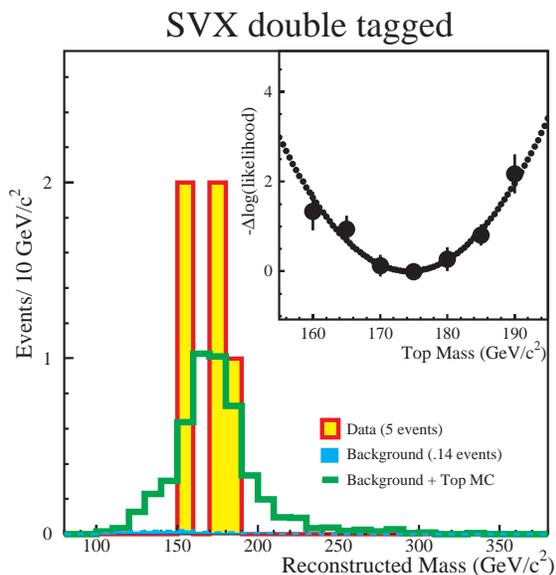
# *Lepton + Jets Top Mass Measurement*



- **Event selection.**
  - ◆ One high  $p_T$  lepton ( $e$  or  $\mu$ ).
  - ◆ Missing  $E_T$ .
  - ◆ Four jets.
  - ◆  $b$ -tag (CDF, DØ) or event shape (DØ).
- **Mass Estimator.**
  - ◆ 2C constrained fit to  $t\bar{t} \rightarrow \ell + \text{jets}$  hypothesis.
- **Likelihood fit.**
  - ◆ Fit data to expectation from signal and background. Maximize likelihood with respect to top quark mass.

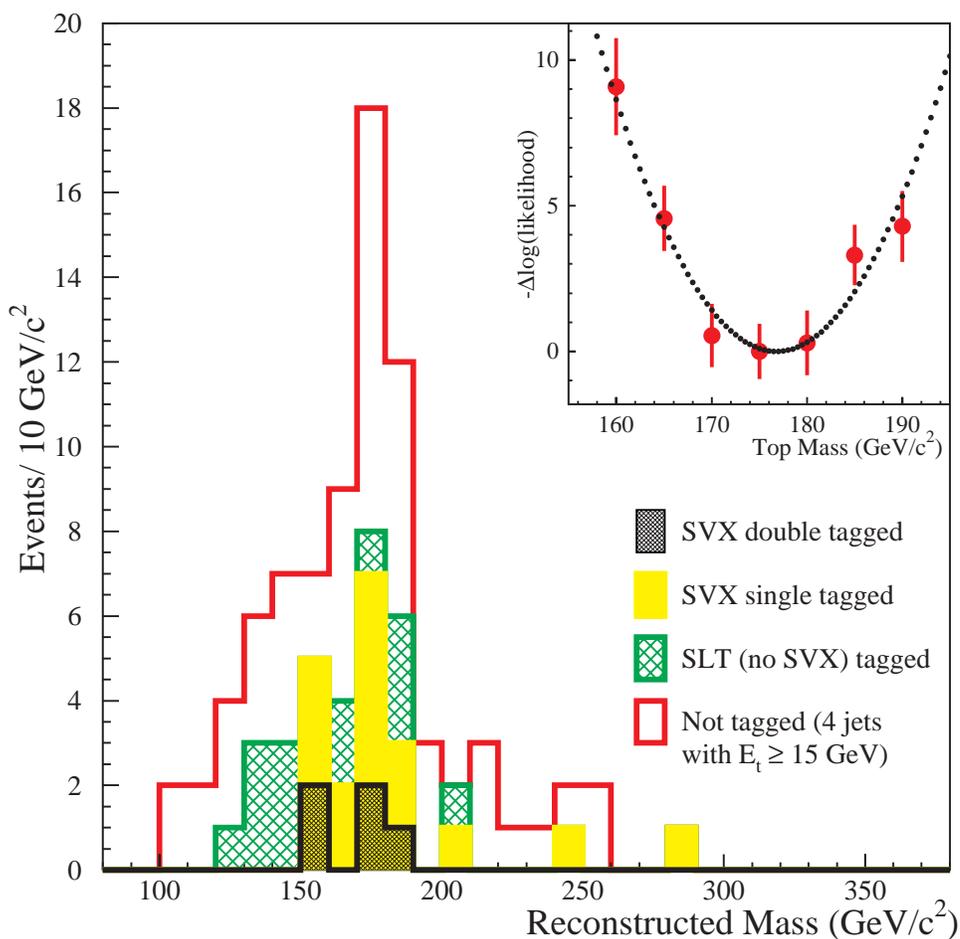
# CDF Lepton + Jets Top Mass

- Calculate likelihoods for four independent subsamples.



# CDF Lepton + Jets Top Mass

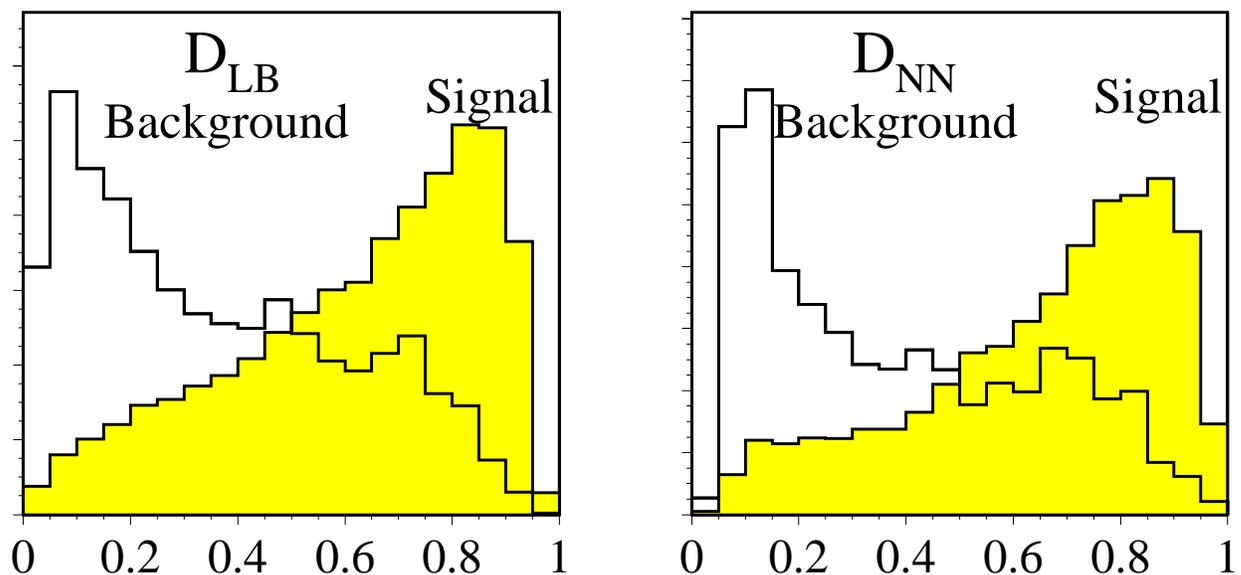
- Final likelihood is product of subsample likelihoods.



$$m_t = 176.8 \pm 4.4 \text{ (stat.)} \pm 4.8 \text{ (syst.) } \text{GeV}/c^2$$

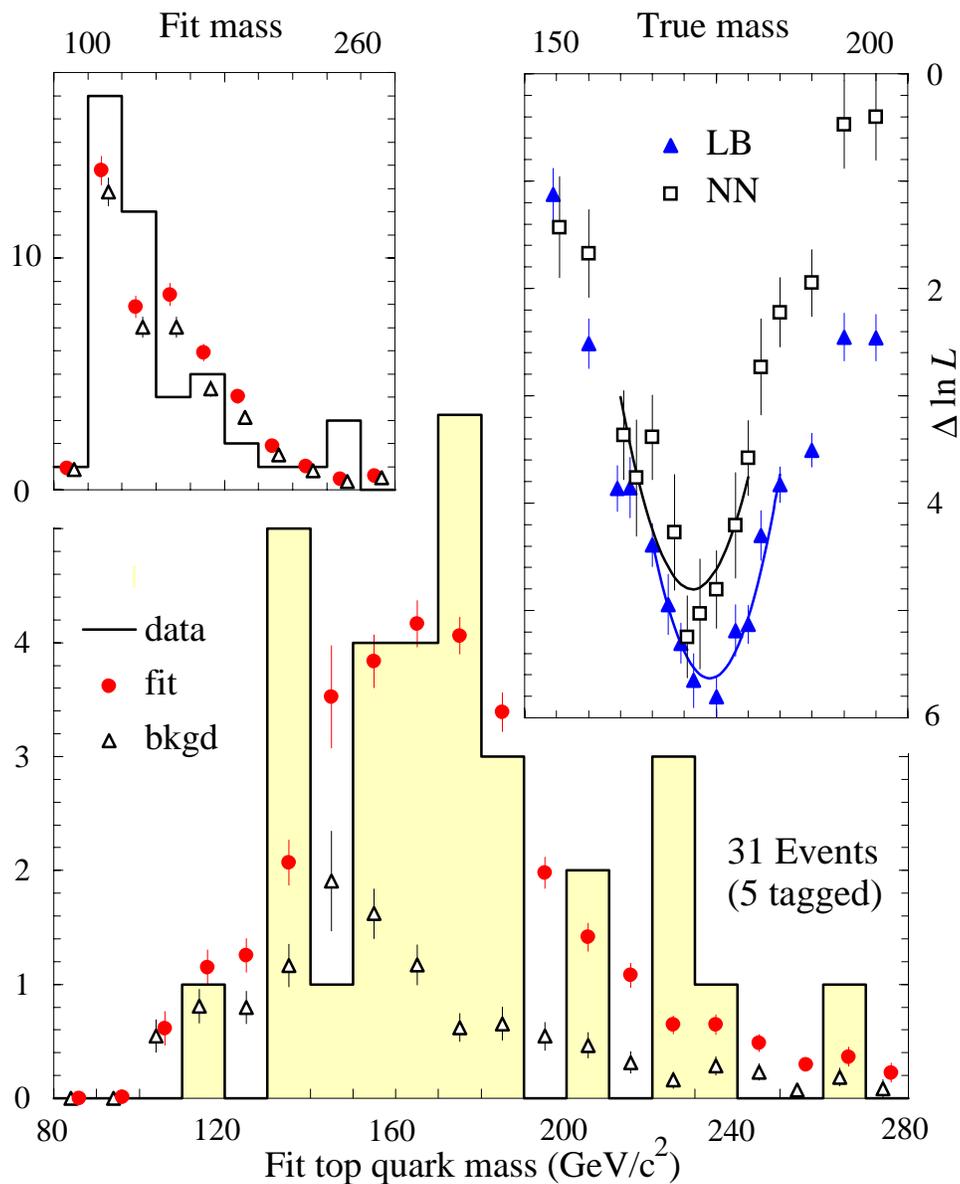
## $D\bar{D}$ Lepton + Jets Top Mass

- Event shape analysis based on four mass-insensitive variables.
- Two independent analyses based on two multivariate discriminants.
  - ◆ “Low bias” discriminant ( $D_{LB}$ ).
  - ◆ Neural Network discriminant ( $D_{NN}$ ).



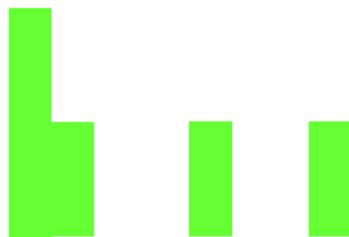
- Two dimensional likelihood fit ( $D$  vs.  $m_t$ ).

# *DØ Lepton + Jets Top Mass*



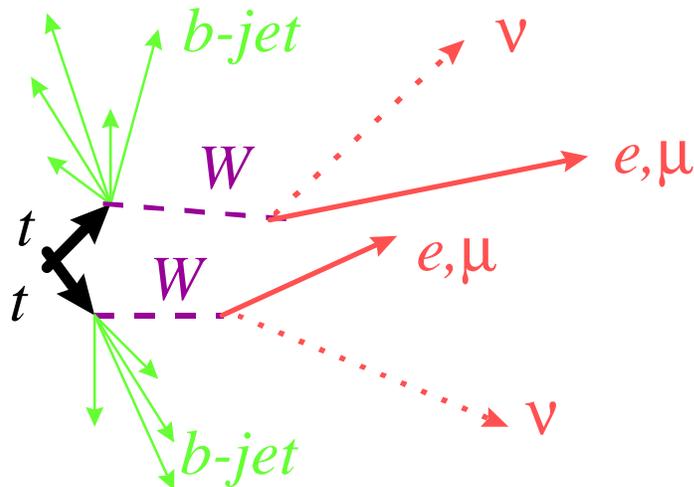
$$m_t = 173.3 \pm 5.6 \text{ (stat.)} \pm 6.2 \text{ (syst.) } \text{GeV}/c^2$$

PRL 79, 1197 (1997)



b-tag events

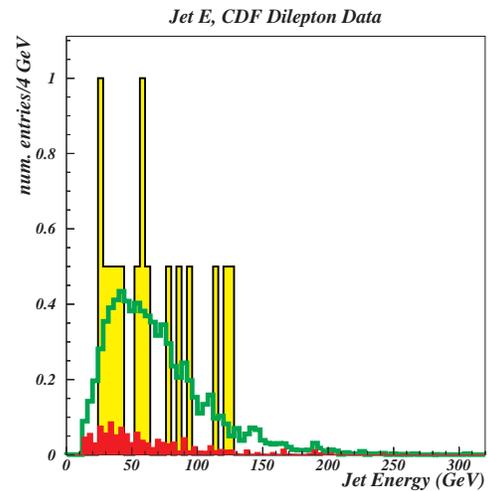
# Dilepton Top Mass Measurement



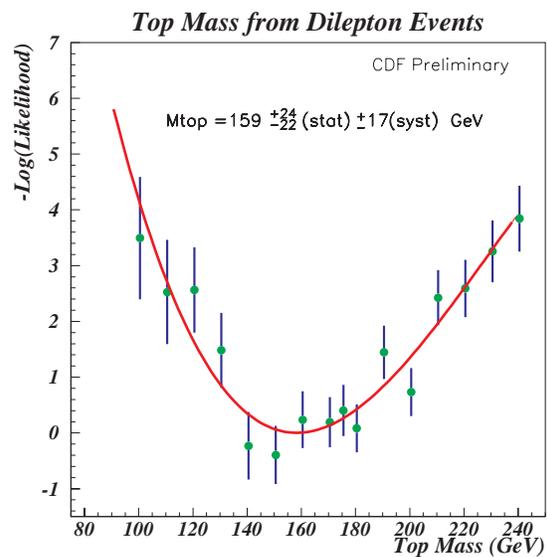
- Event selection.
  - ◆ Two high  $p_T$  leptons ( $e$  or  $\mu$ ).
  - ◆ Missing  $E_T$ .
  - ◆ Two jets.
  - ◆  $H_T = \Sigma E_T(\text{jets})$ .
- Mass Estimator (no reconstructed mass).
  - ◆ CDF.
    - ▷ Jet energy (CDF).
    - ▷  $m_{\ell b}$  (CDF).
  - ◆  $D\emptyset$ .
    - ▷ Matrix element weight.
    - ▷ Neutrino weight.

# CDF Dilepton Top Mass

Jet energy distribution  
(8 events, 16 jets).



Likelihood fit.

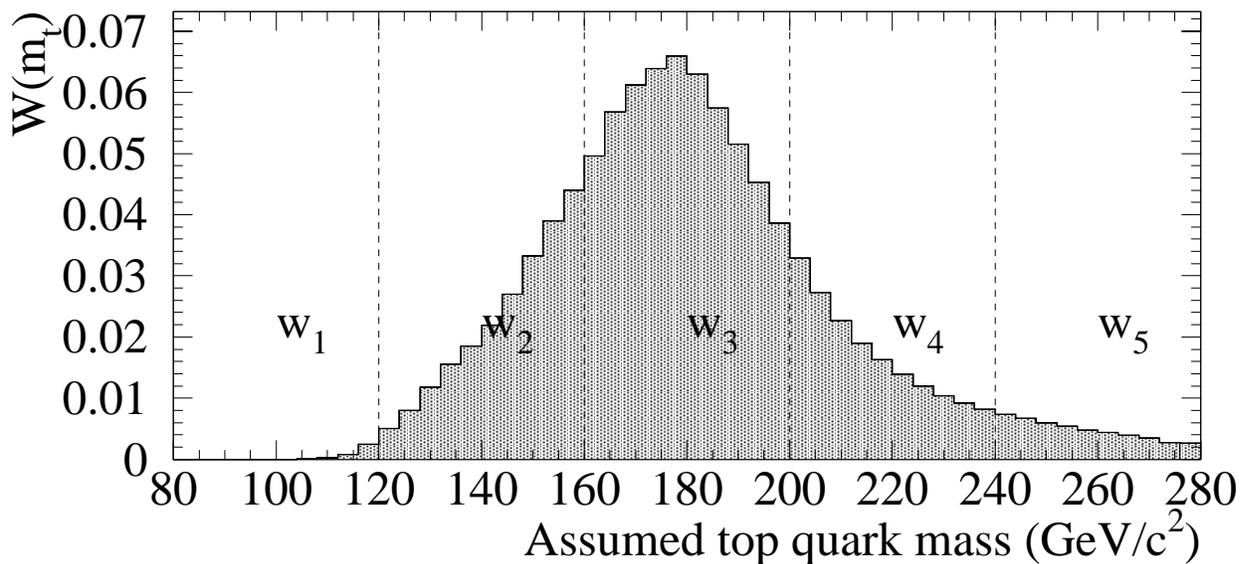


$$m_t = 159^{+24}_{-22} \text{ (stat.)} \pm 17 \text{ (syst.) GeV}/c^2 \text{ (Jet } E_T)$$

$$m_t = 162 \pm 21 \text{ (stat.)} \pm 7 \text{ (syst.) GeV}/c^2 \text{ (} m_{\ell b}$$

## *DØ Dilepton Top Mass*

- Weight curve method.
  - ◆ Assume a top quark mass & reconstruct event.
  - ◆ Calculate weight curve as a function of  $m_t$ .\*



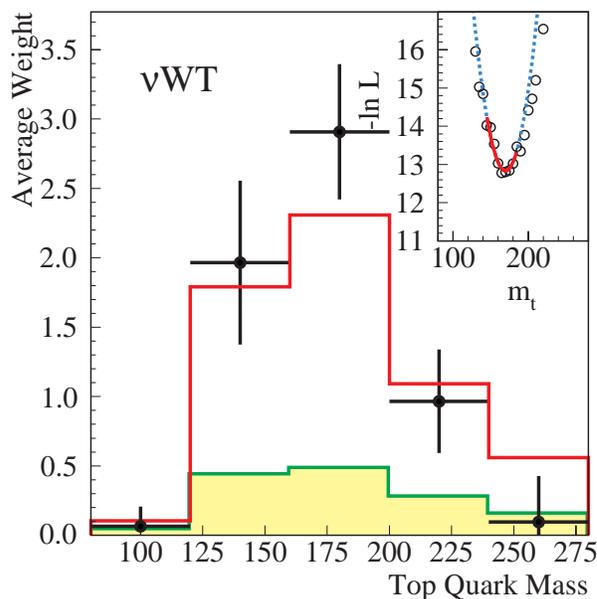
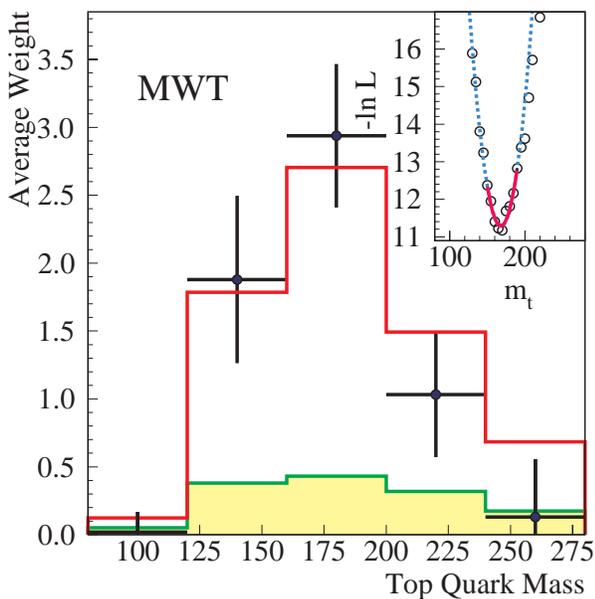
- Extract four values for each dilepton event.

\* K. Kondo, J. Phys. Soc. Jpn. 57, 4126 (1988) and 60, 836 (1991).

R.H. Dalitz and G.R. Goldstein, Phys. Rev. D 51, 4763 (1995).

# *DØ Dilepton Top Mass*

- Six events.
- Four dimensional likelihood fit using four dimensional top and background templates.



$$m_t = 168.4 \pm 12.3 \text{ (stat.)} \pm 3.7 \text{ (syst.) GeV}/c^2$$

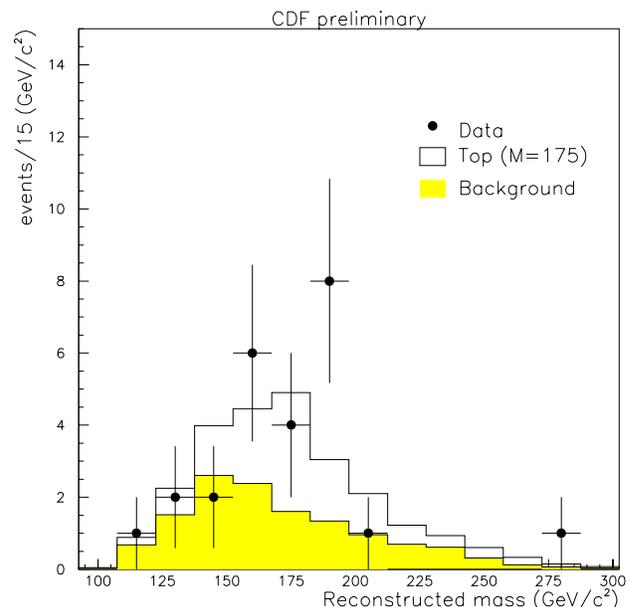
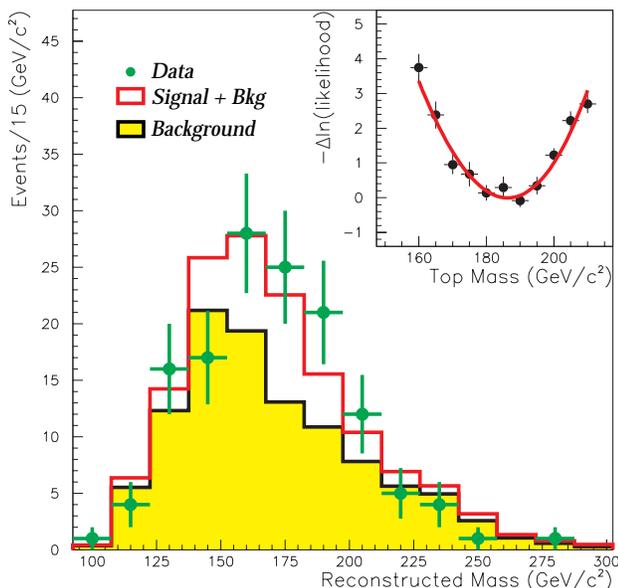
Submitted to PRL, Fermilab-Pub-97/172-E, hep-ex/9706014.

# CDF All Jets Top Mass

- Event selection.
  - ◆ Six jets.
  - ◆  $b$ -tag.
  - ◆ Event shape (aplanarity,  $\Sigma E_T/m(\text{jets})$ ).
  - ◆ 136 events, est. background  $108 \pm 9$ .
- Mass Estimator.
  - ◆ 3C constrained fit to  $t\bar{t} \rightarrow$  all jets hypothesis.

Single  $b$ -tags

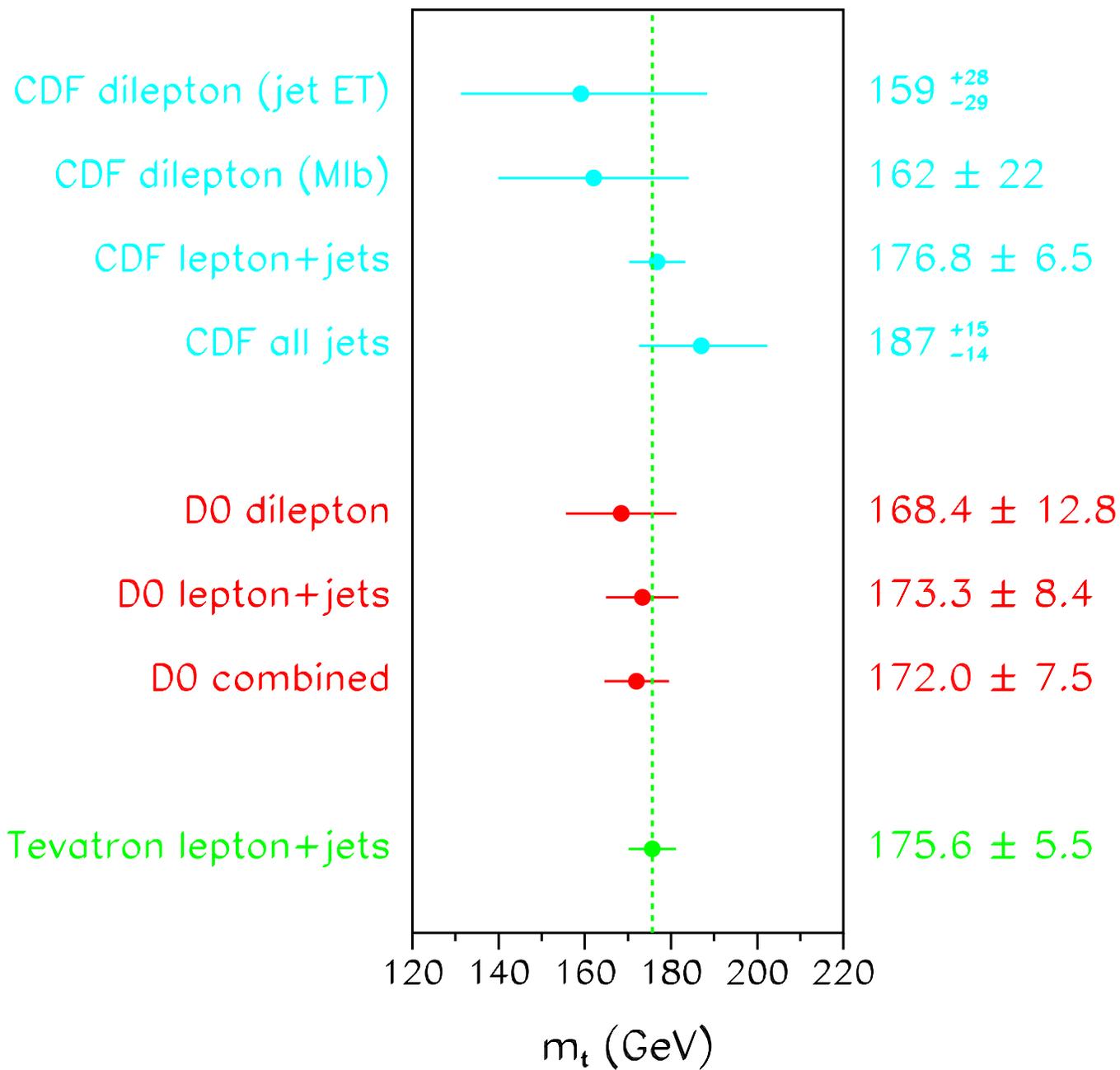
Double  $b$ -tags



$$m_t = 187 \pm 8 \text{ (stat.) } {}^{+13}_{-12} \text{ (syst.) GeV}/c^2$$

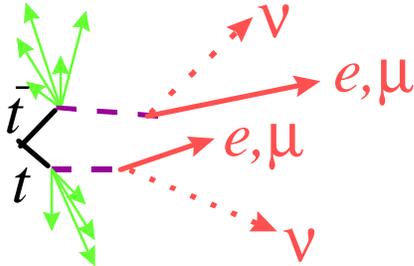
Submitted to PRL, Fermilab-Pub-97/075-E.

# Top Quark Mass Summary



# Top Quark Cross Section

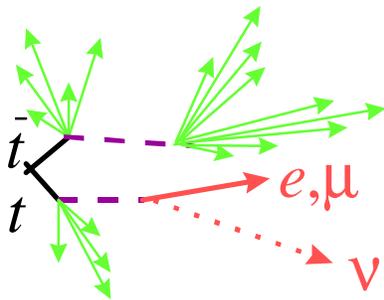
- Dilepton ( $ee, e\mu, \mu\mu + 2 \text{ jets} + \text{missing } E_T$ ).



	Data	Background
CDF	9	$2.1 \pm 0.4$
DØ	5	$1.4 \pm 0.4$

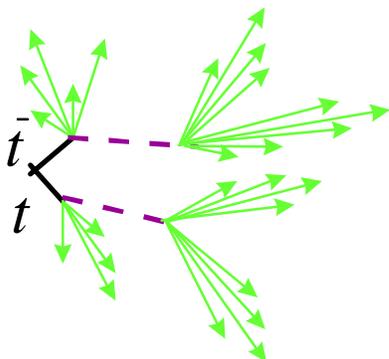
- Lepton + jets ( $e, \mu + 3 \text{ or } 4 \text{ jets} + \text{missing } E_T$ ).

- ▷ Vertex or soft lepton  $b$ -tag.
- ▷ Shape, aplanarity and  $H_T = \Sigma E_T(\text{jets})$  (DØ).



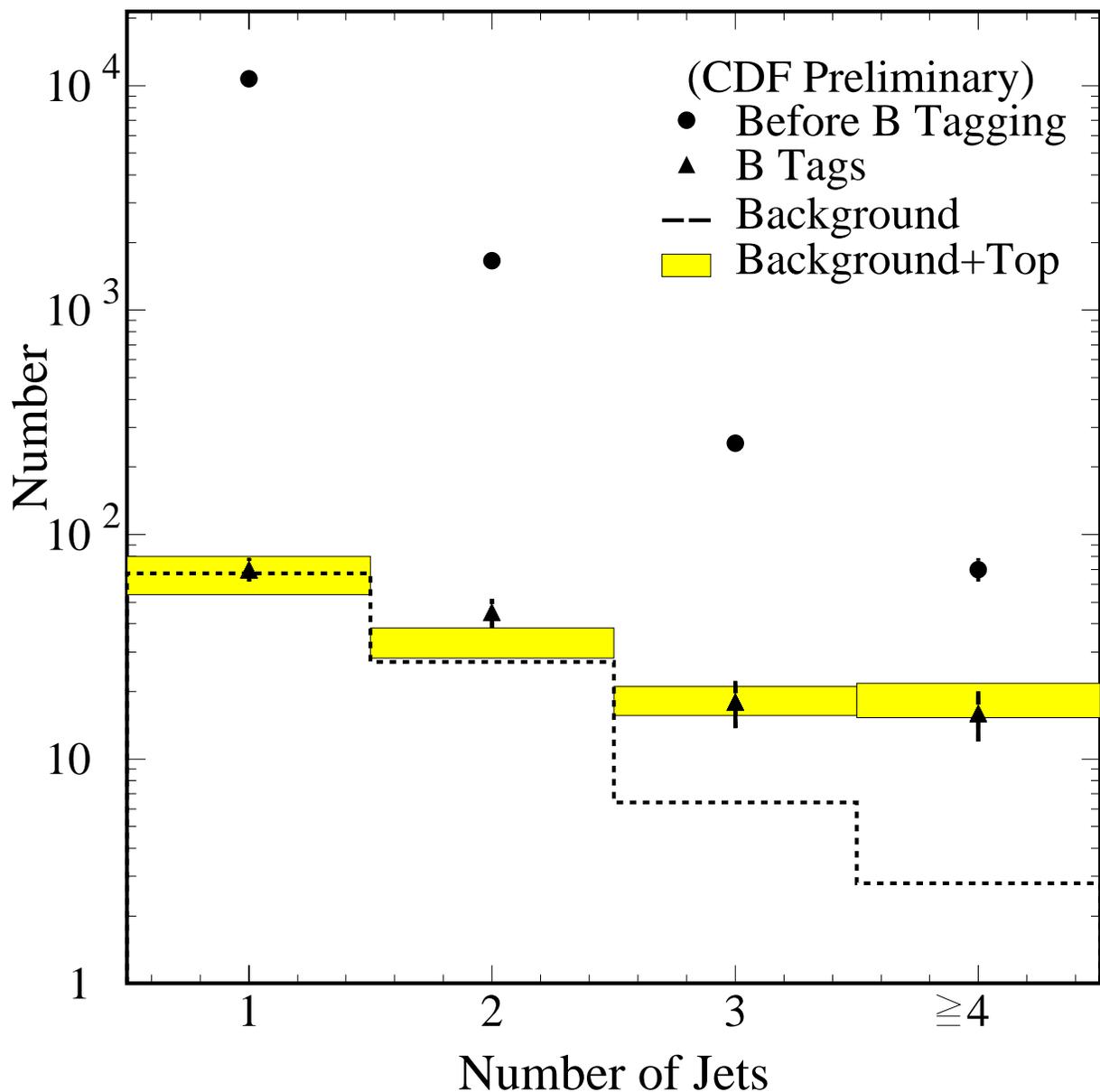
	Data	Background
CDF SVX	34	$8.0 \pm 1.4$
CDF SLT	40	$24.3 \pm 3.5$
DØ $\mu$ -tag	11	$2.4 \pm 0.5$
DØ shape	19	$8.7 \pm 1.7$

- All jets (5 or 6 jets, 1 or 2  $b$ -tags, event shape).

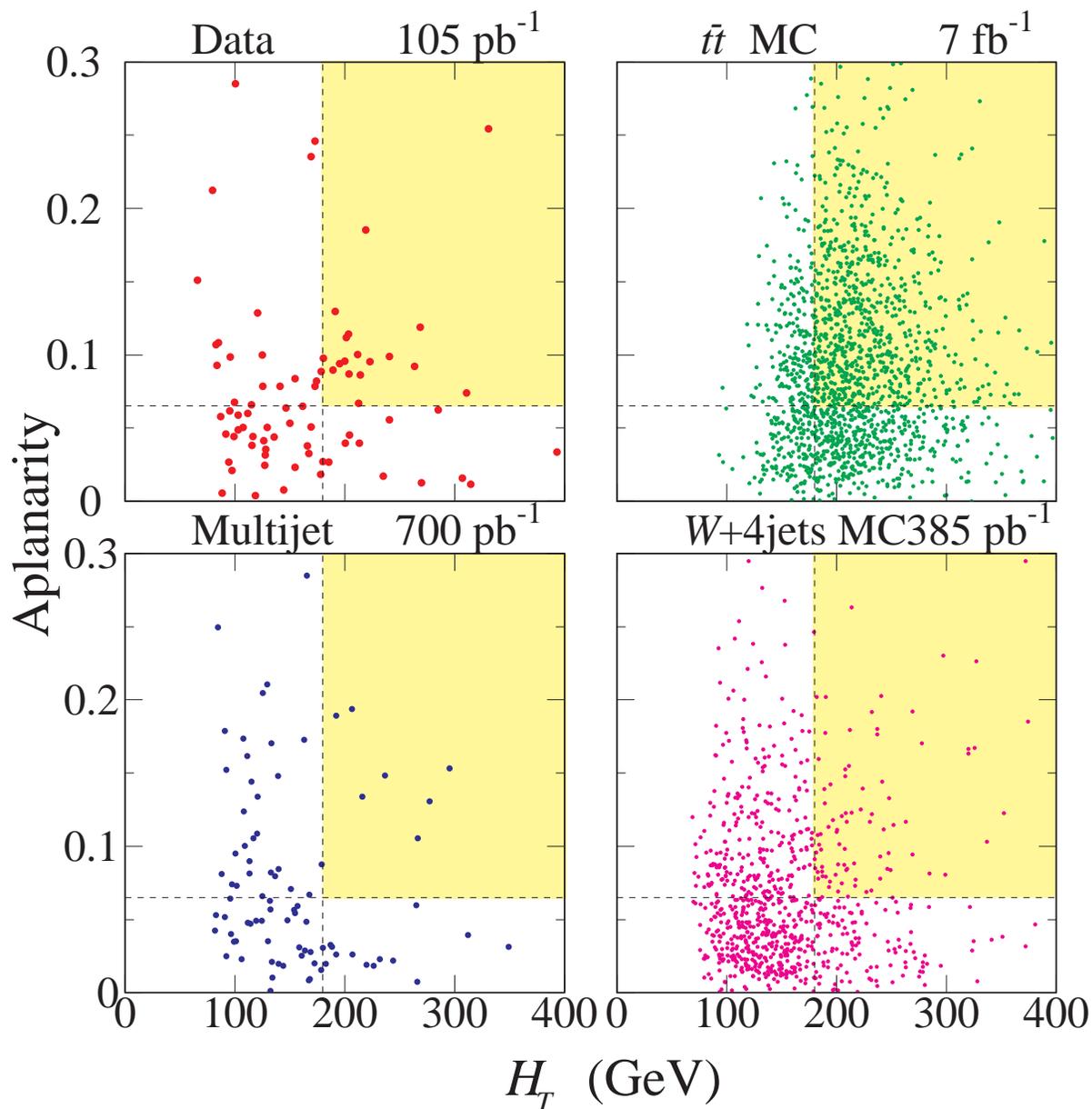


	Data	Background
CDF $1b$	187	$142 \pm 12$
CDF $2b$	157	$120 \pm 18$
DØ $1b$	44	$25.3 \pm 3.1$

# *CDF Lepton + Jets SVX b-Tag Analysis*

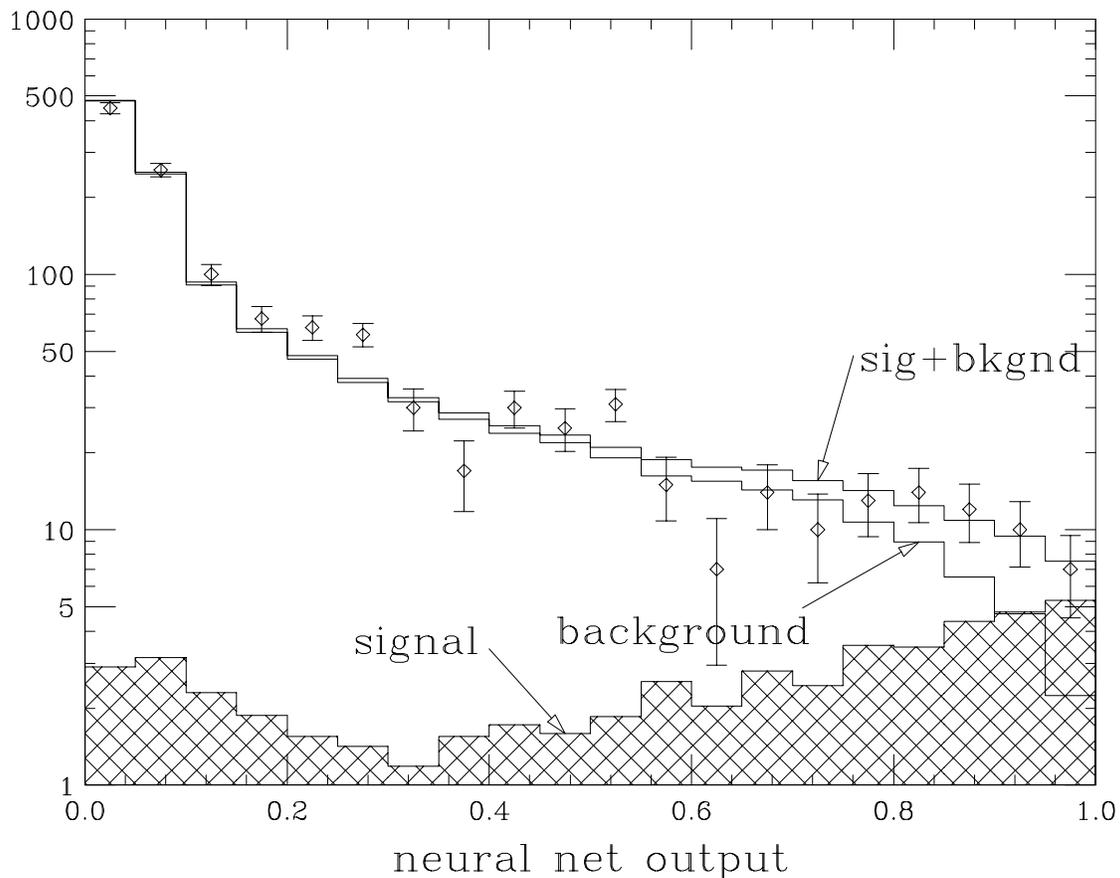


# *DØ Lepton + Jets Event Shape Analysis*



# *DØ All Jets Analysis*

- Basic selection: 6 jets + soft  $\mu$   $b$ -tag.
  - ◆ Additional selection using 11 variable neural network including:
    - ▷  $H_T = \Sigma E_T(\text{jets})$  and other energy variables..
    - ▷ Event shape (aplanarity, sphericity, centrality, etc.).
    - ▷ Jet width (quark/gluon discriminator).

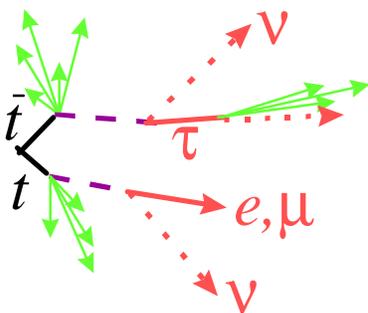


$$\sigma_{tt} = 7.9 \pm 3.1 \text{ (stat.)} \pm 1.7 \text{ (syst.) pb}$$

# Top Quark Cross Section (cont.)

- Other Signatures.

- ◆  $\ell\tau$  (CDF) ( $e, \mu + \text{hadronic } \tau + 2 \text{ jets} + \text{missing } E_T$ ).
- ◆  $e\nu$  (DØ) ( $e + 2 \text{ jets} + \text{missing } E_T$ ).
  - ▷ Very high missing  $E_T$  ( $E_T^{\text{miss}} > 50 \text{ GeV}$ ).
  - ▷ High transverse mass ( $M_T > 115 \text{ GeV}$ ).



	Data	Background
CDF $\ell\tau$	4	$2.0 \pm 0.4$
DØ $e\nu$	4	$1.2 \pm 0.4$

- Publications

DØ dilepton, lepton+jets,  $e\nu$ , PRL **79**, 1203 (1997)

CDF all jets, submitted to PRL, Fermilab-Pub-97/075-E.

CDF  $\ell\tau$ , submitted to PRL, Fermilab-Pub-97/096-E.

## Summary of CDF Results

$$\int \mathcal{L} dt \approx 110 \text{ pb}^{-1}$$

$$m_t = 175 \text{ GeV}/c^2$$

Channel	$\epsilon \times \text{BR}(\%)$	Data	Bckgd	$\sigma_{t\bar{t}}$ (pb)
<b>Dilepton</b>	$0.74 \pm 0.08$	9	$2.1 \pm 0.4$	$8.5 +4.4 -3.4$
$l+j$ (SVX)	$3.5 \pm 0.7$	34	$8.0 \pm 1.4$	$6.8 +2.3 -1.8$
$l+j$ (SLT)	$1.7 \pm 0.3$	40	$24.3 \pm 3.5$	$8.0 +4.4 -3.6$
<b>Combined</b>	—	83	33.4	<b><math>7.5 +1.9 -1.6</math></b>
<b>Had<sup>1</sup></b>	$4.4 \pm 0.9$	187	$142 \pm 12$	$9.6 +4.4 -3.6$
<b>Had<sup>2</sup></b>	$3.0 \pm 0.9$	157	$120 \pm 18$	$11.5 +7.7 -7.0$
<b>Had<sup>1+2</sup></b>	—	—	—	$10.1 +4.5 -3.6$
<b><math>\tau</math>-dilepton</b>	$0.12 \pm 0.014$	4	$2.0 \pm 0.4$	$15.6 +19 -13^*$

<sup>1</sup>: single tag + kinematics; <sup>2</sup>: double tag  
\*: statistical uncertainty only

## Summary of DØ Results

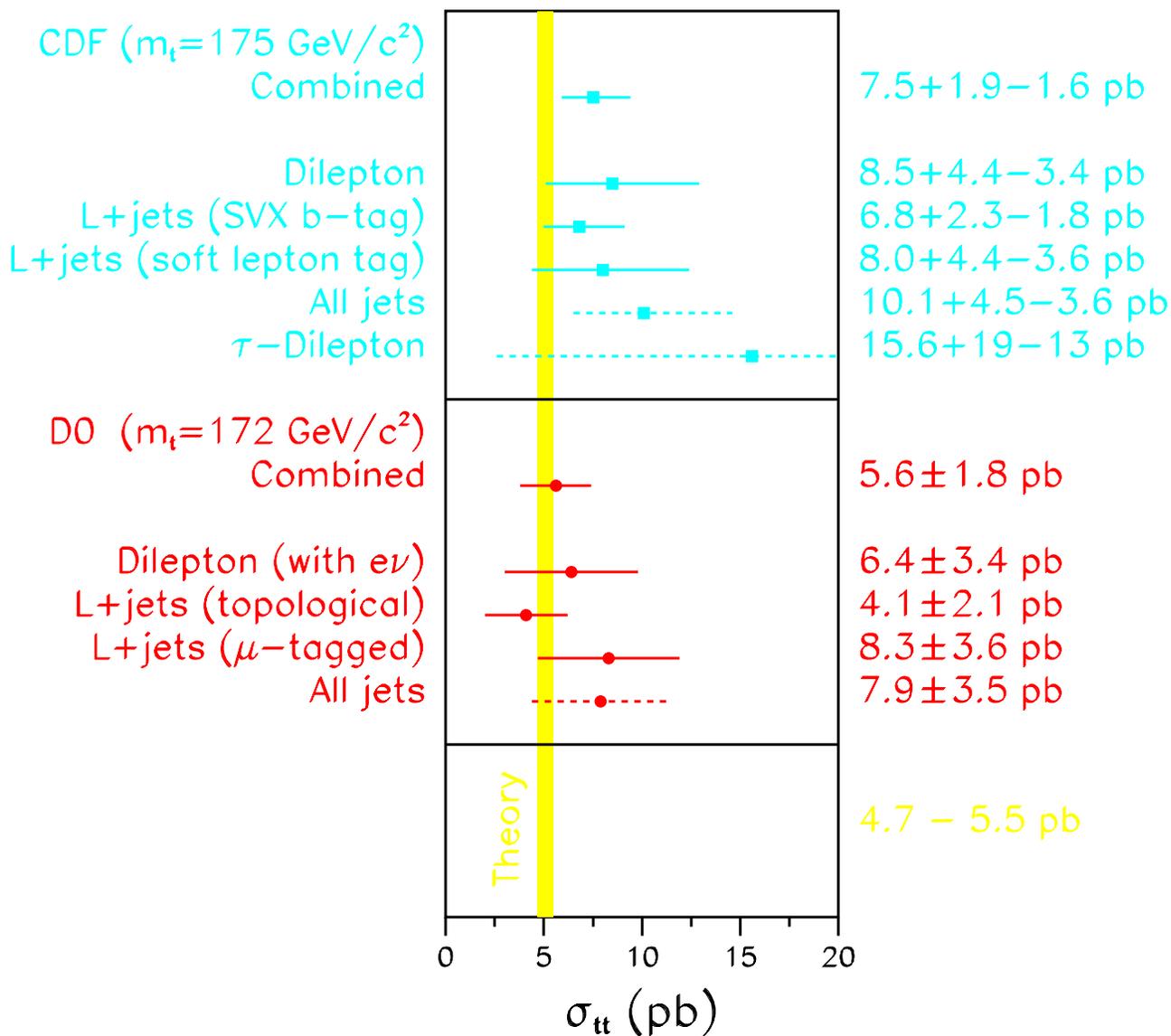
$$\int \mathcal{L} dt \approx 125 \text{ pb}^{-1}$$

$$m_t = 172 \text{ GeV}/c^2$$

Channel	$\epsilon \times \text{BR}(\%)$	Data	Bckgd	$\sigma_{t\bar{t}}$ (pb)
$ll$ (with $e\nu$ )	$0.91 \pm 0.17$	9	$2.6 \pm 0.6$	$6.4 \pm 3.4$
$l+j$ (topol.)	$2.17 \pm 0.46$	19	$8.7 \pm 1.7$	$4.1 \pm 2.1$
$l+jets/\mu$	$0.96 \pm 0.15$	11	$2.4 \pm 0.5$	$8.3 \pm 3.6$
<b>Combined</b>	$4.14 \pm 0.69$	39	$13.7 \pm 2.2$	<b><math>5.6 \pm 1.8</math></b>
<b>All jets</b>	$1.8 \pm 0.4$	44	$25.3 \pm 3.1$	<b><math>7.9 \pm 3.5</math></b>

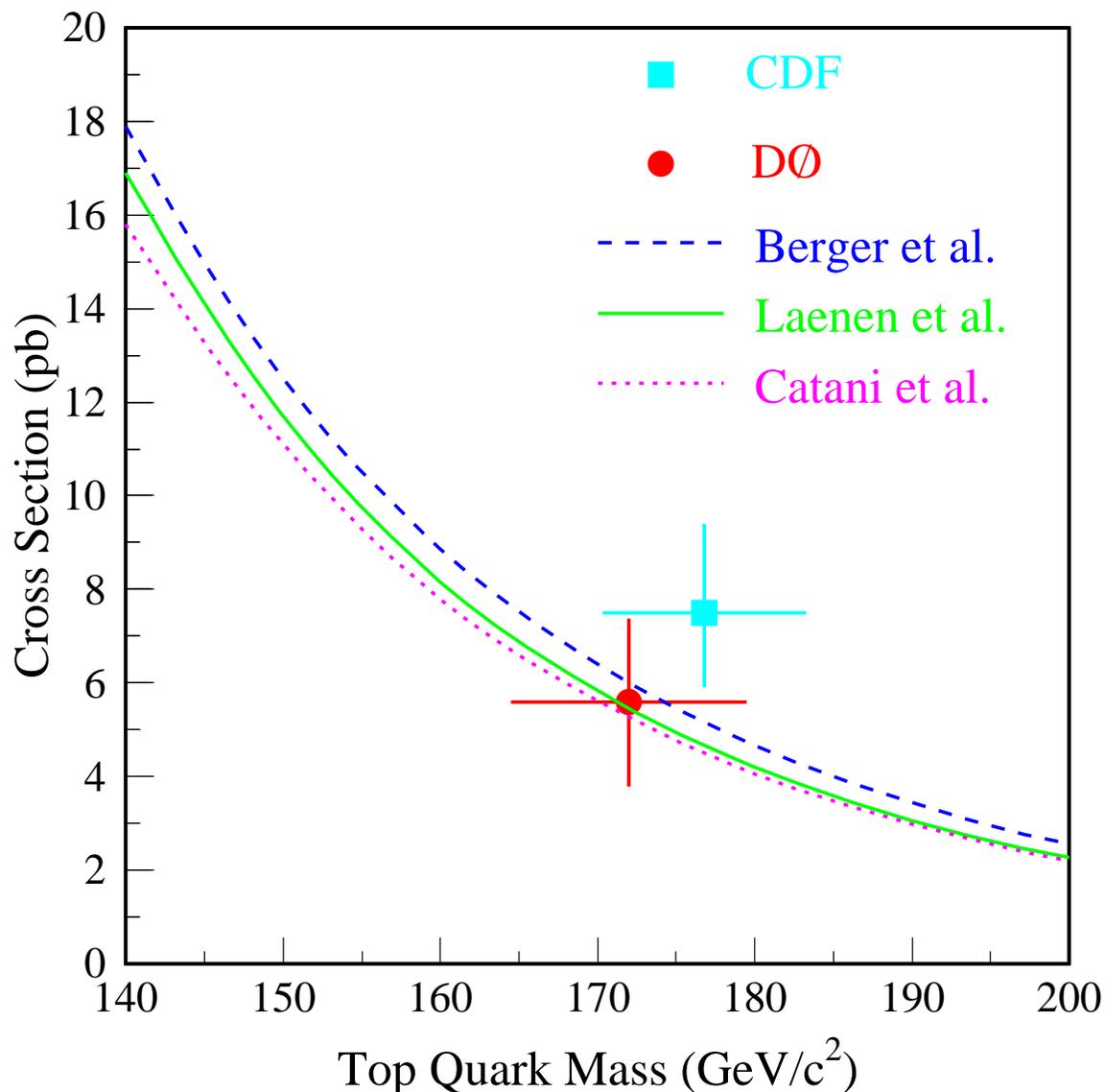
# Top Cross Section Results

Top Cross Sections



Combined cross sections do not include dashed results

# Top Quark Cross Section vs. Mass



**CDF**  $\sigma_{tt} = 7.5^{+1.9}_{-1.6} \text{ pb}$  ( $@m_t = 175.0 \text{ GeV}/c^2$ )

**DØ**  $\sigma_{tt} = 5.6 \pm 1.8 \text{ pb}$  ( $@m_t = 172.0 \text{ GeV}/c^2$ )

## *Other CDF Top Quark Results*

- Upper limit on top decaying to charged Higgs.

$$m_{H^\pm} > 147 \text{ GeV}/c^2 \quad (\sigma_{tt} = 5.0 \text{ pb}, \tan\beta = \infty)$$

$$m_{H^\pm} > 158 \text{ GeV}/c^2 \quad (\sigma_{tt} = 7.5 \text{ pb}, \tan\beta = \infty)$$

Submitted to PRL Fermilab-Pub-97/058-E.

- Upper limit on the FCNC decays of the top quark.

$$\text{BR}(t \rightarrow q\gamma) < 2.9\% \quad @ \quad 95\% \text{ CL}$$

$$\text{BR}(t \rightarrow qZ) < 44\% \quad @ \quad 95\% \text{ CL}$$

- Measurement of  $R_b = \Gamma(t \rightarrow Wb)/\Gamma(t \rightarrow Wq)$   
 $= |V_{tb}^{3\text{gen}}|^2$ .

$$R_b = 1.23_{-0.31}$$

$$+0.37$$

## *Future Top Physics at the Tevatron*

- Tevatron run 2 begins late 1999.
- Expect  $\int L dt = 2 \text{ fb}^{-1}$  per experiment (20 times current data of  $100 \text{ pb}^{-1}$ ).
- $\sqrt{s} = 2.0 \text{ TeV}$  (35% increase in  $tt$  cross section relative to current  $\sqrt{s} = 1.8 \text{ TeV}$ ).
- Expected top event yield about 40 times current sample:

	Events per experiment	<i>S:B</i>
Dilepton	200	5:1
$\ell + 3 \text{ jets} + b\text{-tag}$	1400	3:1
$\ell + 4 \text{ jets} + 2b\text{-tags}$	600	12:1
Single top	180	1:2

## Conclusions

- Both Tevatron experiments have measured the top quark mass.

$$m_t = 176.8 \pm 6.5 \text{ GeV} \quad \text{CDF}$$

$$m_t = 172.0 \pm 7.5 \text{ GeV} \quad \text{D}\emptyset$$

$$m_t = 175.6 \pm 5.5 \text{ GeV} \quad \text{Tevatron}$$

- Both Tevatron experiments have measured the top quark production cross section.

$$\sigma_{tt} = 7.5^{+1.9}_{-1.6} \text{ pb} \quad @ \quad m_t = 175 \text{ GeV} \quad \text{CDF}$$

$$\sigma_{tt} = 5.6 \pm 1.8 \text{ pb} \quad @ \quad m_t = 172 \text{ GeV} \quad \text{D}\emptyset$$

- Expect 40 times current top quark event samples in run 2 (begins late 1999).

## *Different Techniques*

- Different signatures are better suited to different values of  $\beta$ 
  - ◆  $\beta=1 \Leftrightarrow eejj$  (best for explaining HERA events)
  - ◆  $\beta=0.5 \Leftrightarrow evjj$
  - ◆  $\beta=0.0 \Leftrightarrow vvjj$
- CDF uses kinematic selection, and then stresses mass analysis
  - ◆ if a signal were observed, this would provide measurement of the particle mass
- DØ uses loose initial selection, and formal optimization of kinematic selection
  - ◆ “Random Grid Search” (RGSearch)<sup>[1]</sup> and neural net analyses give same result

[1] N. Amos *et al.*, in **Proceedings of the International Conference on Computing in High Energy Physics '95**, pp. 215—219.

# *LQ<sub>1</sub> Search: CDF eejj channel*

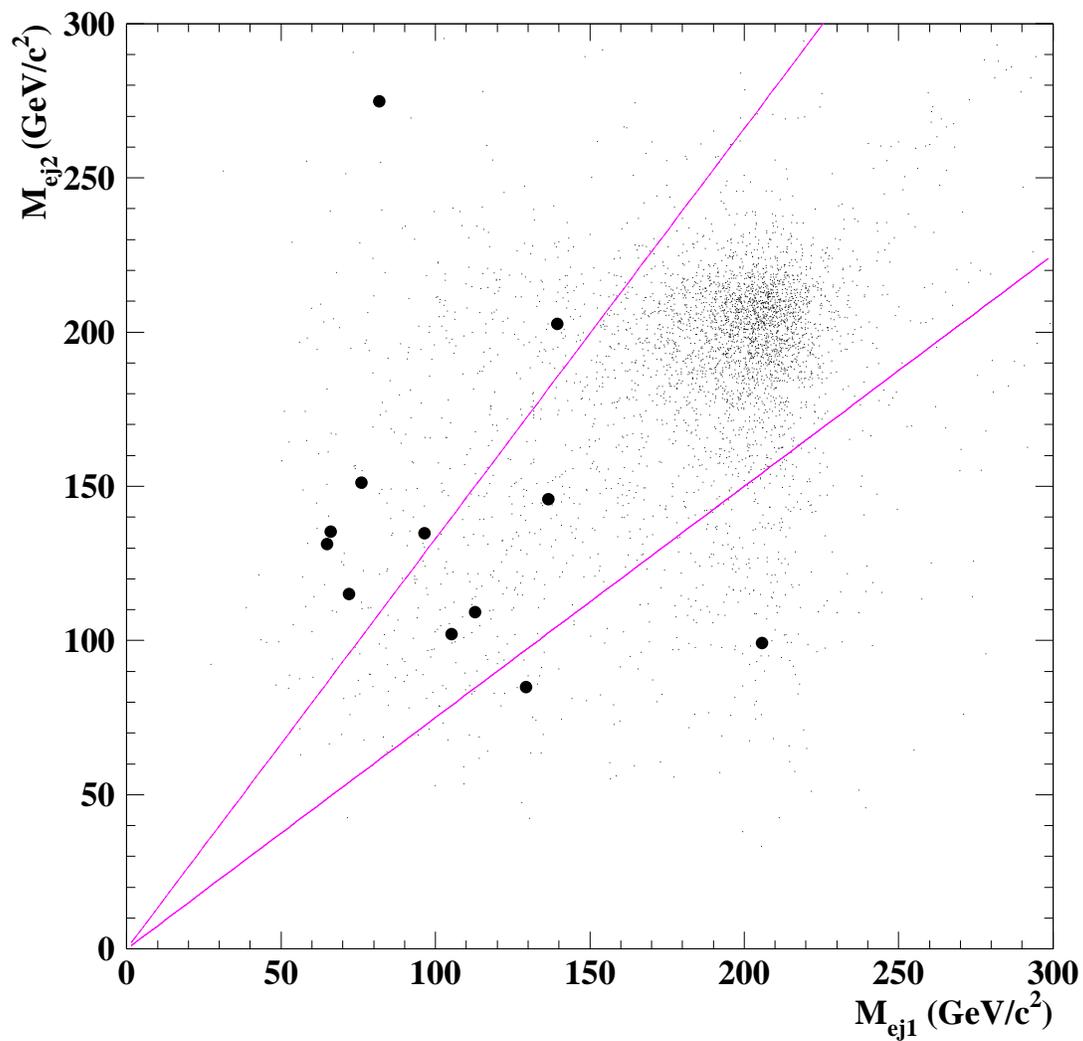
- Integrated luminosity: 110 pb<sup>-1</sup>
- signature: 2e + 2 jet
- Major backgrounds are top and Drell-Yan/Z

Selection Criteria	Observed Number of Events	Signal Efficiency (200 GeV )
2 electrons, E <sub>T</sub> > 25 GeV	7466	50%
2 jets, E <sub>T1</sub> > 30 GeV, E <sub>T2</sub> > 15 GeV	228	45%
m <sub>ee</sub> < 76 GeV <i>or</i> m <sub>ee</sub> > 106 GeV	27	41%
E <sub>Te1</sub> + E <sub>Te2</sub> > 70 GeV E <sub>Tj1</sub> + E <sub>Tj2</sub> > 70 GeV	12	40%
<i>ej</i> invariant mass cuts	3	28%
Expected Background	5.8± 2.2	—

- All final candidates have m<sub>ej</sub> < 140 GeV
- Signal efficiencies calculated with PYTHIA
  - ◆ ~21% for LQ<sub>1</sub> with mass 140 GeV/c<sup>2</sup>
  - ◆ ~28% for LQ<sub>1</sub> with mass 240 GeV/c<sup>2</sup>

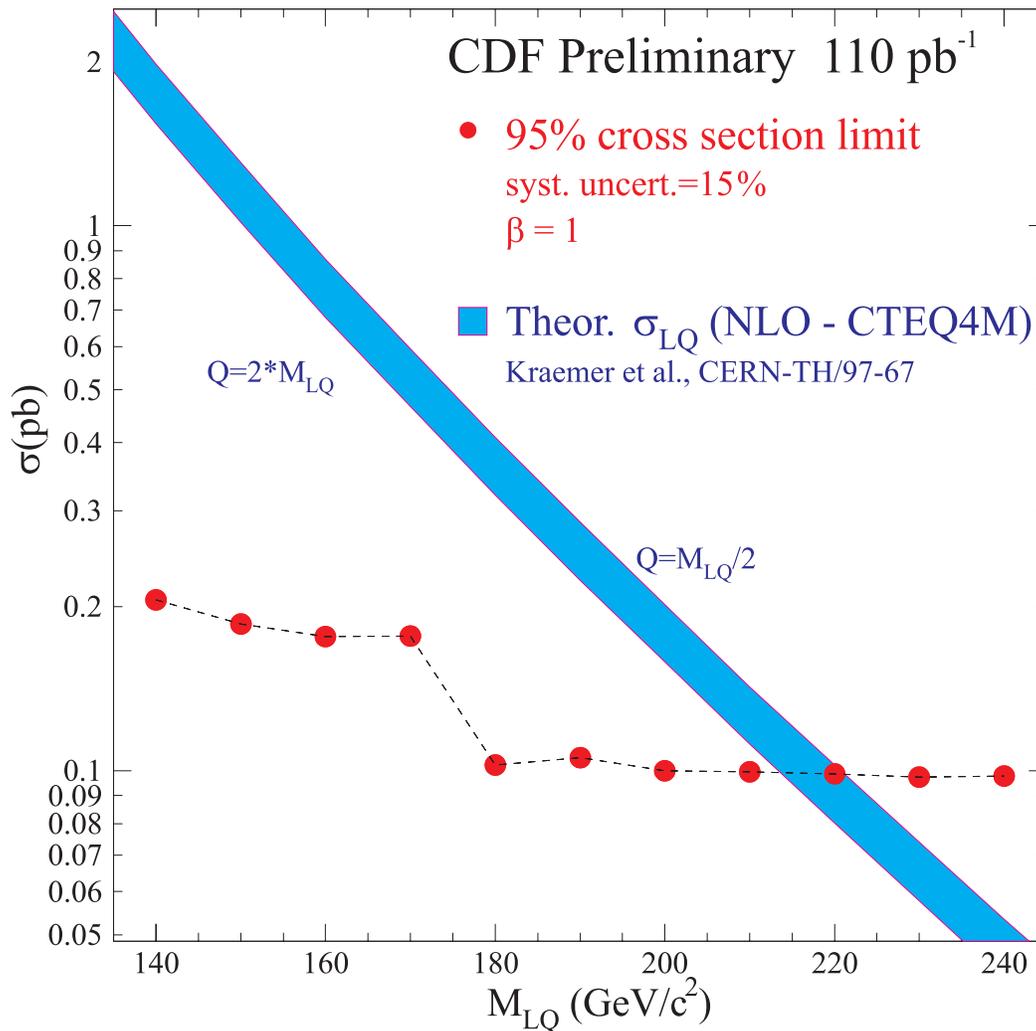
# *Electron-jet mass correlations*

- CDF data vs. LQ<sub>1</sub> (200 GeV) Monte Carlo



# $LQ_1$ Cross Section Limit: CDF

- 95% CL mass limit of 213 GeV for  $\beta=1$
- for  $LQ_1$  mass 180-240 GeV, limit is 0.1 pb



# *LQ<sub>1</sub> Search: DØ eejj channel*

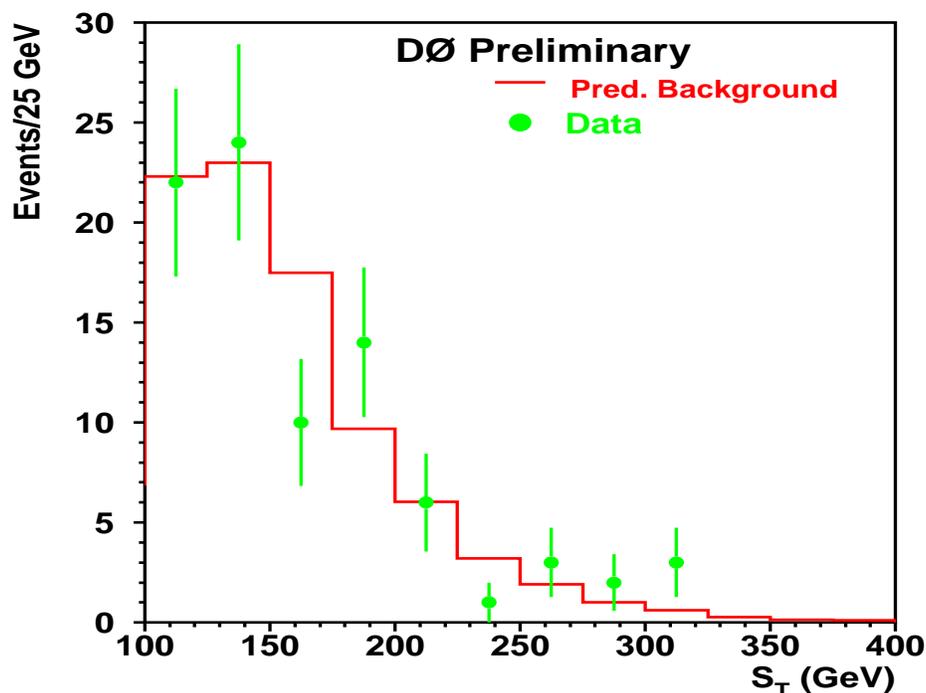
- Integrated luminosity: 123 pb<sup>-1</sup>
- signal: 2e + 2 jet

Selection Criteria	Observed Number of Events	Signal Efficiency (200 GeV)
2 EM clusters, E <sub>T</sub> > 20 GeV 2 jets, E <sub>T</sub> > 15 GeV	2918	67%
DR(e - jet) > 0.7	2496	56%
m <sub>ee</sub> < 82 GeV <i>or</i> m <sub>ee</sub> > 100 GeV	1802	53%
at least one “tight” electron additional “loose” electron	101	40%

- Formal optimization technique used to determine final selection criteria
  - ◆ maximized expected signal, while constraining expected background to a fixed level (0.4 events)

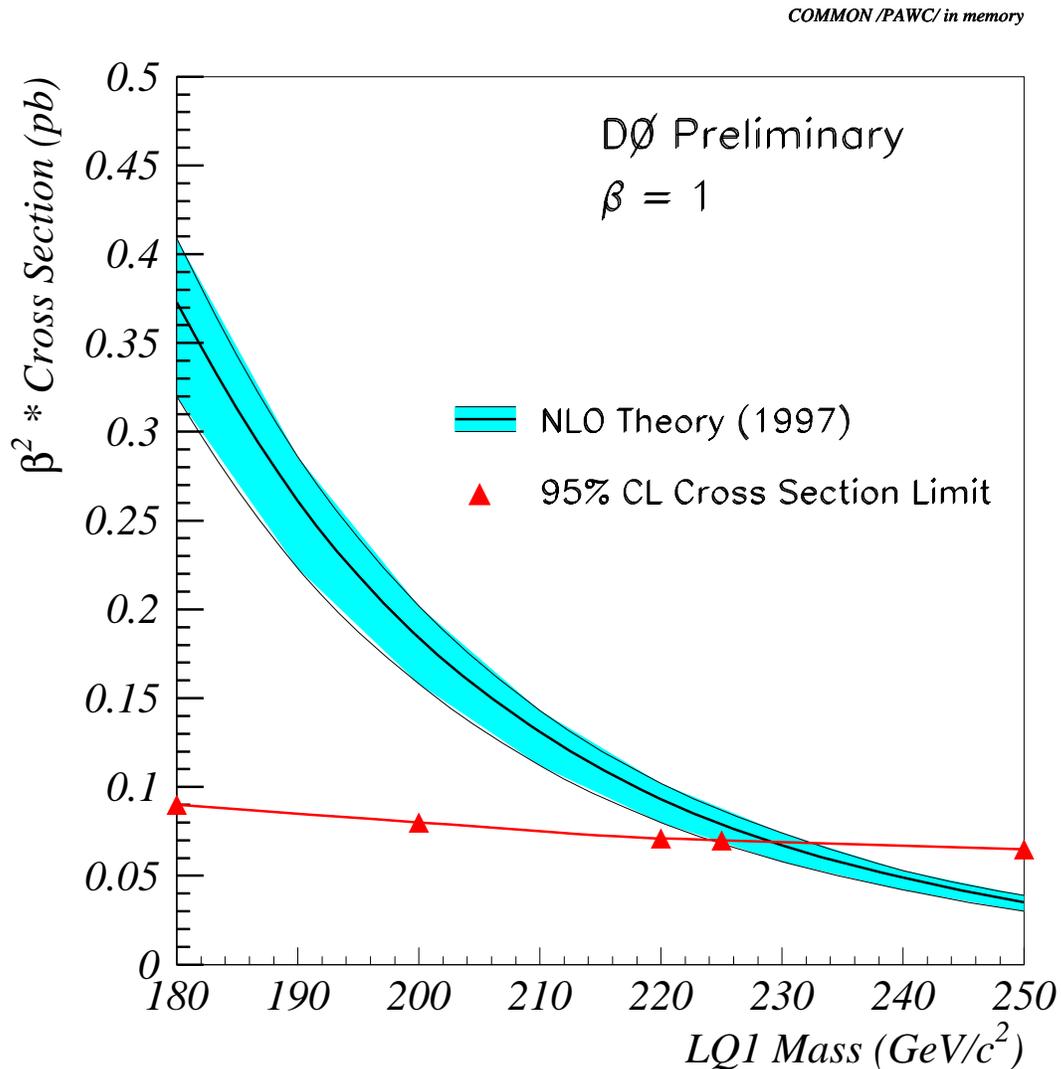
## *2 e + 2 jet optimization*

- ~50 different combinations of variables tested in Random Grid search
- Single most effective variable was  $S_T$ 
  - ◆  $E_{Te1} + E_{Te2} + \Sigma E_T$  (all jets with  $E_T > 15$  GeV)
- Final selection  $S_T > 350$  GeV
  - ◆ 0 events observed;  $0.44 \pm 0.06$  expected from SM
  - ◆ final signal efficiency 16-36% for mass 160-250



# $LQ_1$ Cross Section Limit: $D\emptyset$

- 95% CL mass limit of 225 GeV for  $\beta=1$
- for  $LQ_1$  mass 180-250 GeV, limit is 0.09 pb-0.07 pb

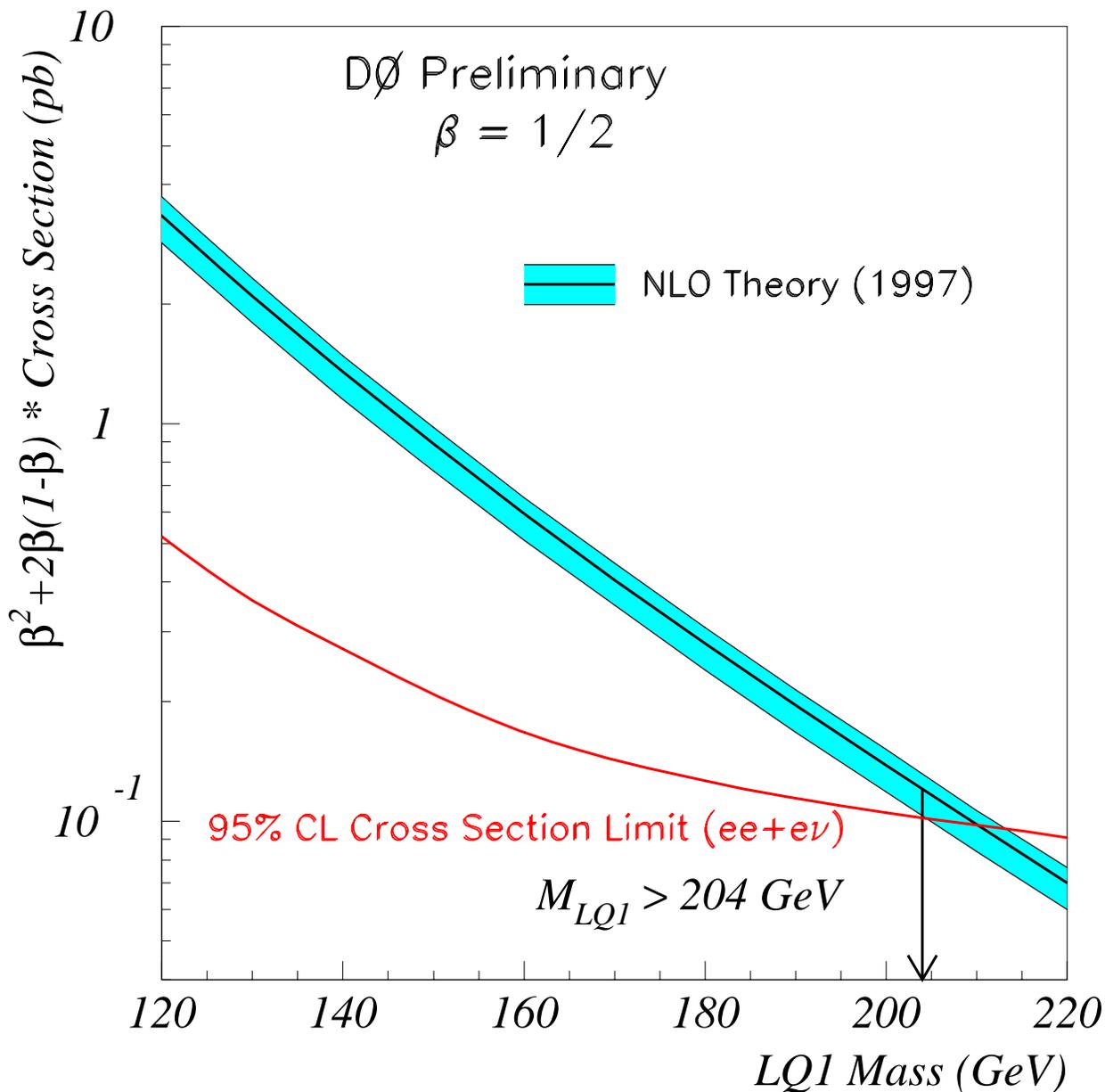


## $e + \nu + 2 \text{ jet Channel}$

- For  $\beta=0.5$ , the  $eejj$  channel is sensitive to only 25% of the  $LQ_1$  cross section
  - ◆ 25%  $eejj$
  - ◆ 25%  $\nu\nu jj$
  - ◆ 50%  $e\nu jj$
- Both CDF and DØ also use the  $e\nu jj$  channel to search for  $LQ_1$  production
  - ◆ electron + missing transverse energy ( $ME_T$ ) + 2 jets
  - ◆ Major backgrounds:  $tt$  and  $W + 2$  jets
- CDF
  - ◆ single  $e$ , large  $ME_T$ , 2 jets,  $b$ -tag veto
  - ◆ transverse mass  $> 120$  GeV
  - ◆ observe 2 events, predicted background  $3.2 \pm 0.8$
- DØ
  - ◆ single  $e$ , large  $ME_T$ , 2 jets,  $ST > 170$  GeV, no isolated muons, mass window cut
  - ◆ observe 0 events, predicted background is  $\sim 0.4$

# First Generation Leptoquarks

## eejj+ evjj search



**$M_{LQ1} > 204 \text{ GeV}/c^2$  for  $\beta = 0.5$**

## *Summary of $LQ_1$ Limits*

- LQ1 mass limit for  $\beta=1$  depends only on the  $eejj$  cross section limit
- LQ1 mass limit for  $\beta=0.5$  depends on a combination of the  $eejj$  and  $evjj$  limits
- mass limits at 95% CL

$\beta=1$

- ◆  $m > 225$  GeV (DØ)
- ◆  $m > 213$  GeV (CDF)

$\beta=0.5$

- ◆  $m > 204$  GeV (DØ,  $eejj + evjj$ )
- ◆  $m > 180$  GeV (CDF,  $evjj$ )



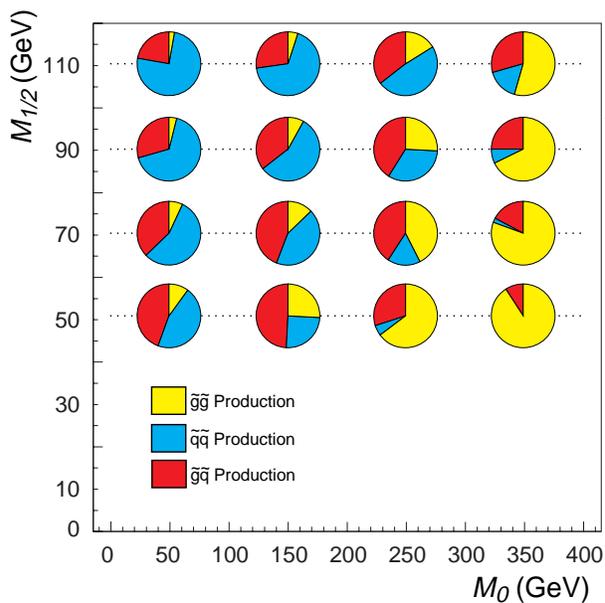
# *Jets + $ME_T$ : $D\emptyset$*

- 79 pb<sup>-1</sup> integrated luminosity

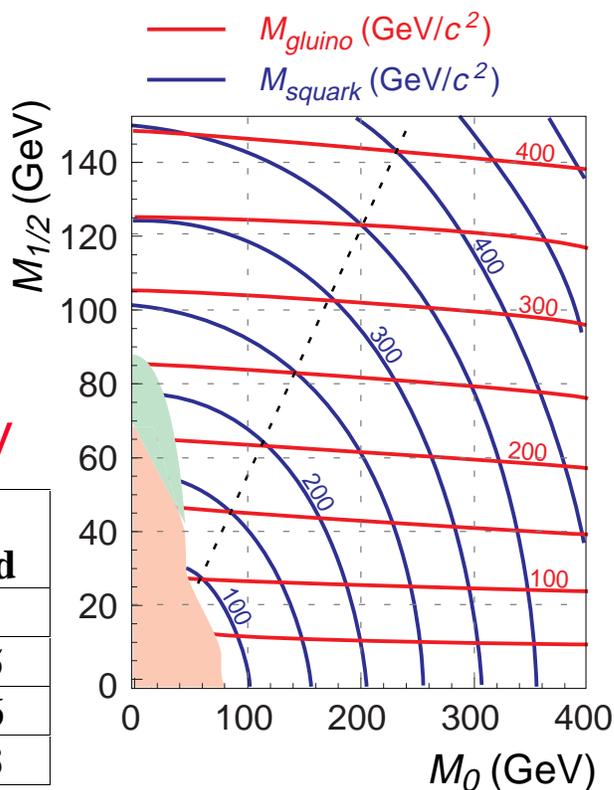
<b>Selection Criteria</b>	<b>Observed Number of Events</b>
ME <sub>T</sub> > 40 GeV 1 jet E <sub>T</sub> > 115 GeV, 3 jets E <sub>T</sub> > 25 GeV	2723
ME <sub>T</sub> not aligned with/against jet	550
Σ (jet=2..N) E <sub>T</sub> = H <sub>T2</sub> > 100 GeV	431
ME <sub>T</sub> > 75 GeV	50
no isolated muons	49
leading E <sub>T</sub> jet confirms vertex	15
Expected Background	9.3 ± 3.5

- Final selection criteria optimized for different regions of SUGRA parameter space
  - ◆ H<sub>T2</sub> cuts from 100 to 150 GeV
  - ◆ ME<sub>T</sub> cuts from 75 to 100 GeV
- Signal efficiencies vary from 1-10%

# *Jets + $ME_T$ : $D\emptyset$*



Features of the  
 SUGRA mass  
 plane

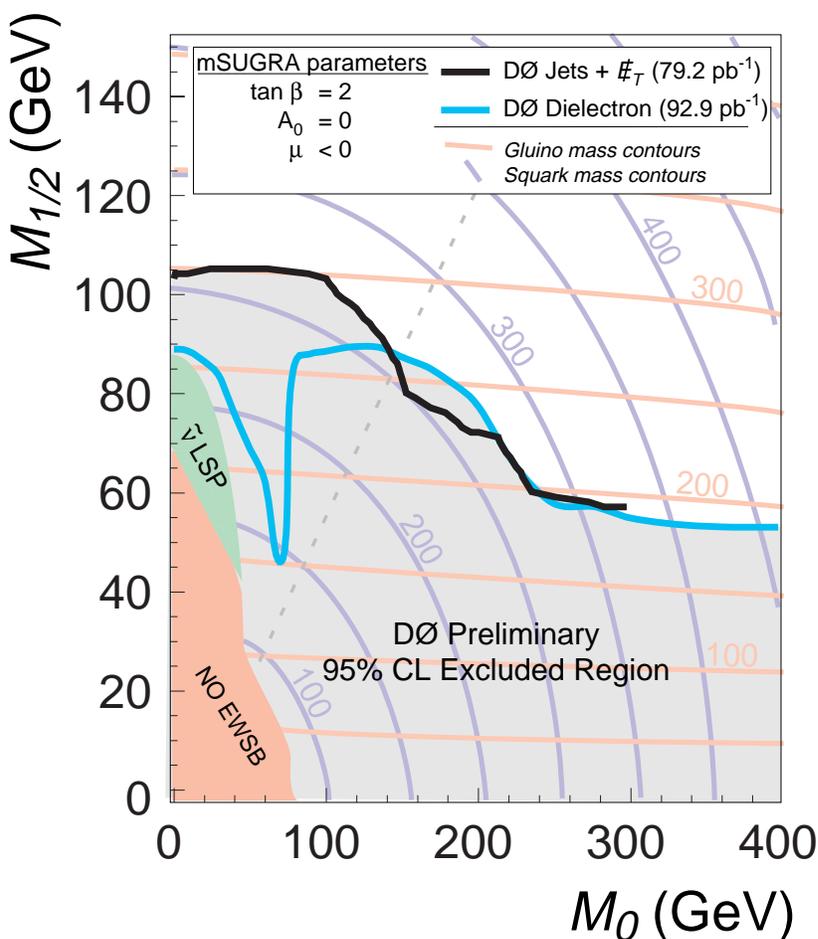


Events with  $H_{T2} > 100$  GeV

$ME_T$ Threshold	Events Observed	Events Predicted
50	49	$44 \pm 9$
75	15	$9.3 \pm 3.5$
90	8	$7.0 \pm 2.6$
100	7	$5.6 \pm 2.3$

# *SUGRA exclusion contour: DØ*

- 95% CL exclusion contour determined in  $(m_0, m_{1/2})$  parameter space of minimal low energy supergravity (SUGRA)



- asymptotic limit  
 $m_{\text{gluino}} > 185 \text{ GeV}$
- equal squark & gluino  
 $m > 260 \text{ GeV}$   
 $(m > 267 \text{ from } ee)$

# CDF Summary

Searches	Current CDF limit (GeV/c <sup>2</sup> ) (mostly Preliminary) Excluded region at 95% C.L.	data set(pb <sup>-1</sup> )
W' → eν (SM)	< 652	1a (20)
W' → μν (SM)	< 646	1b (90)
W' → WZ	< 560	1a+1b (110)
Z' → ℓℓ (SM)	< 690	1a+1b (110)
Z <sub>ψ</sub> , Z <sub>η</sub> , Z <sub>χ</sub> , Z <sub>I</sub>	< 580, 610, 585, 555	1a+1b (110)
Z <sub>LR</sub> , Z <sub>ALRM</sub>	< 620, 590	1a+1b (110)
Axigluon → dijet	200 < M < 930	1a+1b (103)
Technirho → dijet	250 < M < 500	1a+1b (103)
topgluon , = .1M	200 < M < 550	1a (20)
topgluon , = .5M	200 < M < 370	1a (20)
Leptoquark(1st gen.)	< 213(scalar, β = 1)	1a+1b(110)
Leptoquark(2nd gen.)	< 195(scalar, β = 1)	1a+1b(110)
Leptoquark(3rd gen.)	< 99(scalar, β = 1)	1a+1b(110)
Leptoquark(3rd gen.)	< 170, 225(vector, κ = 0, 1)	1a+1b(110)
Pati-Salam LQ(B <sub>s</sub> -eμ)	< 12100	1b (88)
Pati-Salam LQ(B <sub>d</sub> -eμ)	< 18300	1b (88)
Composit, Scale (qqee)	< 3400(-), 2400(+)	1a+1b (110)
Composit, Scale (qqμμ)	< 3500(-), 2900(+)	1a+1b (110)
q*(W+jet, γ+jet)	< 540	1a (20)
q* → dijet	200 < M < 750	1a+1b (103)
charged stable ptl.	< 195(color tripl. q)	1b (90)
gluino(MSSM)	< 180(all $\tilde{q}$ mass)	1b (80)
gluino(MSSM)	< 230(M <sub><math>\tilde{q}</math></sub> = M <sub><math>\tilde{g}</math></sub> )	1b (80)
gaugino(MSSM)	< 68 ( $\tilde{\chi}_1^\pm, \tilde{\chi}_2^0$ )	1a+1b (110)
H <sup>±</sup>	< 150 for tan β > 100 or < 1	1a+1b (100)
H <sup>0</sup> ( $\bar{p}p \rightarrow WH^0, H^0 \rightarrow bb$ )	σ > 20pb	1a+1b (110)

<http://www-cdf.fnal.gov/physics/exotic/exotic.html>

# *DØ Summary*

Particle	Signature	DØ 95% confidence level limit
$\tilde{W}_R$	Resonance in e $E_T$ spectra 2 e's, 2 jets	650 GeV/c <sup>2</sup> for $M(N_2) < \frac{1}{2}M(W_R)$
$b'$	2 $\gamma$ 's and 2 jets 1 $\gamma$ , 2 jets, b-tag	$M > M_Z + M_b$ $M > M_Z + M_b$
Higgs	W $\rightarrow$ e, $\mu$ plus $\nu$ plus 2 jets with btag W $\rightarrow$ jj plus 2 $\gamma$ 's	$\sigma < 50$ pb at 80 GeV/c <sup>2</sup> *, $\sigma < 19$ pb at 120 GeV/c <sup>2</sup> * 81 GeV/c <sup>2</sup> *
$\tilde{q}$ 's	3 jets and $\cancel{E}_T$ 2 e's, 2 jets, and $\cancel{E}_T$	260 GeV/c <sup>2</sup> for $M(\tilde{q})=M(\tilde{g})^*$ 267 GeV/c <sup>2</sup> for $M(\tilde{q})=M(\tilde{g})^*$
$\tilde{g}$ 's	4 jets and $\cancel{E}_T$ 2 e's, 2 jets, and $\cancel{E}_T$	173 GeV/c <sup>2</sup> 185 GeV/c <sup>2</sup> *
$\tilde{W}, \tilde{Z}$	tri-leptons  2 $\gamma$ 's and $\cancel{E}_T$	$\sigma < 66$ fb for $M(\tilde{W}_1)=45\text{GeV}/c^2$ , $\sigma < 100$ fb for $M(\tilde{W}_1)=124\text{GeV}/c^2$ $M(\tilde{W}_1) > 156\text{GeV}/c^2^*$
$\tilde{e}$ or $\tilde{\nu}$	2 $\gamma$ 's and $\cancel{E}_T$	$\sigma < 200$ fb for $M(\tilde{W}_1)-M(\tilde{Z}_1) > 30\text{GeV}/c^2^*$
$Z'$	di-jets di-electrons	$M < 365\text{GeV}/c^2, M > 615\text{GeV}/c^2^*$ $M > 670\text{GeV}/c^2^*$
$W'$	di-jets e $\nu$	$M < 340\text{GeV}/c^2, M > 680\text{GeV}/c^2^*$ $M > 720\text{GeV}/c^2$
$q^*$	di-jets	$M > 725\text{GeV}/c^2^*$
LQ1	ee jet jet e $\nu$ jet jet $\nu\nu$ jet jet	$M > 225\text{GeV}/c^2, \beta = 1^*$ $M > 192\text{GeV}/c^2, \beta = 0.5^*$ $M > 80\text{GeV}/c^2 \beta = 0.^*$
LQ2	$\mu\mu$ jet jet $\mu\nu$ jet jet $\nu\nu$ jet jet	$M > 184\text{GeV}/c^2, \beta = 1^*$ $M > 140\text{GeV}/c^2, \beta = 0.5^*$ $M > 80\text{GeV}/c^2 \beta = 0.^*$
LQ3	bb $\nu\nu$	$M > 93\text{GeV}/c^2^*$
$\tilde{t}$	acolinear di-jets	$M > 93\text{GeV}/c^2$ for $M(\tilde{Z}_1) < 8\text{GeV}/c^2$

\*  $\rightarrow$  PRELIMINARY RESULT

[http://www-d0.fnal.gov/www\\_buffer/new\\_phenomena/new\\_phenomena.html](http://www-d0.fnal.gov/www_buffer/new_phenomena/new_phenomena.html)

## *Searches: Present and Future*

- The current Tevatron data sample ( $200 \text{ pb}^{-1}$ , shared between CDF and DØ) is the one of most promising current resources for new particle searches
- Both collaborations will continue to exploit their data until the start of Run II of the Tevatron, in 1999
- Running at 2 TeV (12% higher energy), and delivering  $2 \text{ fb}^{-1}$  to each detector before 2002, the Tevatron will provide to CDF and DØ the excellent opportunities for new discoveries
- Fermilab is proposing a Run III, with a goal of  $30 \text{ fb}^{-1}$  for each detector by 2006, by which time the LHC is expected to be fully operational

# Standard Model

## $M_{top}$ vs. $M_W$

